Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

Unlicensed Use of the 6 GHz Band	)	ET Docket No. 18-295
	)	
Expanding Flexible Use in Mid-Band Spectrum between 3.7 and 24 GHz	)	GN Docket No. 17-183
	)	

Comments of
CISCO SYSTEMS, INC.

Mary L. Brown
Senior Director
Technology and Spectrum Policy
Government Affairs
Cisco Systems, Inc.
601 Pennsylvania Ave., NW
9th Floor North
Washington, DC 20004
(202) 354-2923

February 15, 2019

TABLE OF CONTENTS

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

Unlicensed Use of the 6 GHz Band	)	ET Docket No. 18-295
	)	
Expanding Flexible Use in Mid-Band Spectrum between 3.7 and 24 GHz	)	GN Docket No. 17-183
	)	

Comments of
CISCO SYSTEMS, INC.

I. INTRODUCTION AND SUMMARY.

Cisco Systems, Inc. ("Cisco") welcomes the opportunity to respond to the Commission's Notice of Proposed Rulemaking ("NPRM") in the above-captioned proceedings.[1] As it has done previously in these proceedings,[2] Cisco also joins a wide cross-section of the technology industry in group comments dedicated to delivering on the promise of unlicensed spectrum in the 6 GHz band. We file these individual comments to provide information uniquely within our expertise, and, in particular, to respond to the Commission's question on whether it "should allow indoor low-power access point operations in the U-NII-5 and U-NII-7 bands under the same conditions as proposed for the U-NII-6 and U-NII-8 bands."[3] The answer is an unequivocal "yes."

Cisco is a global leader in enterprise networking equipment and applications, as well as the analysis and forecasting of IP and Internet traffic and use cases. Cisco can therefore provide

---

1 *Unlicensed Use of the 6 GHz Band, Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Proposed Rulemaking, FCC No. 18-147, ET Docket No. 18-295, GN Docket No. 17-183 (rel. Oct. 24, 2018) ("NPRM").

2 *See id.* ¶ 17 n.50.

3 *Id.* ¶ 73.

a unique perspective on why opening the full 6 GHz band for low-power indoor operations is so important to the future of connectivity in the United States—and how to do so without causing harmful interference to incumbent operations. Cisco's views are also informed by the hard work of the coalition of unlicensed-wireless advocates of which it is a part, and that coalition's commitment to avoid harmful interference to band incumbents.[4] We look forward to continued dialogue, as we believe that the Commission's final rules can significantly improve spectrum utilization in the band while protecting incumbent interests.

Based on our expertise and these commitments, Cisco respectfully urges the Commission to permit low-power indoor operations throughout the 6 GHz band. The Commission correctly concluded that low-power operations have the potential to "support high throughput and low latency applications for residences and businesses," including "augmented or virtual reality, in-home video distribution at 4K/8K levels, and IoT [Internet of Things] applications."[5] But the Commission's current proposed approach—permitting low-power indoor operations in only 350 megahertz of the 6 GHz band, in two sub-bands that are not adjacent to each other and more distant from the 5 GHz bands—will support only *one* new 160-megahertz channel.

As explained in greater detail below, Cisco's *Visual Networking Index* projects that the wireless technologies and applications most likely to be supported by low-power indoor operations—Internet video, gaming, virtual and augmented reality, indoor smartphone use, and home Internet of Things—are among those that will experience the greatest growth rates in the next several years. The country will need significantly more unlicensed spectrum in order to meet consumer demand for these advances. Opening the full 6 GHz band to low-power indoor

---

4 *See id.* ¶ 17.

5 *Id.* ¶ 59.

operations is therefore essential to unlocking the band's potential for consumers, innovators, and economic growth.

II. NEW SPECTRUM FOR UNLICENSED USES, PARTICULARLY LOW-POWER INDOOR OPERATIONS, IS CRITICAL FOR INNOVATION, ECONOMIC GROWTH, AND U.S. TECHNOLOGICAL LEADERSHIP.

A. Cisco's Visual Networking Index provides key insights into the exploding demand for unlicensed spectrum.

Cisco's *Visual Networking Index* ("VNI")[6] is a powerful tool for industry participants, consumers, and the Commission to identify and understand how global networks are growing and developing, and how different applications are using those networks.[7] The VNI relies on a variety of data sources, as well as projections from analysts around the world, to provide not only a realistic snapshot of present traffic uses and patterns, but also an evidence-based forecast of the future.[8] In addition to providing high-level information and projections as a white paper,[9] the VNI includes a Forecast Highlights Tool that allows users to review highlights from several key categories—including IP Traffic, Internet Traffic, Internet Video, Gaming, and Average Traffic per User and Household. This tool presents data globally, regionally, or as narrow as individual

---

6 *See* Cisco Systems Inc., Cisco VNI Global Fixed and Mobile Internet Traffic Forecasts (2017-2022), https://www.cisco.com/c/en/us/solutions/service-provider/visual-networking-index-vni/index.html (last visited Feb. 11, 2019).

7 *See*, *e.g.*, NPRM ¶ 4 n.5, ¶ 6 n.13 (citing the VNI covering 2016-2021).

8 *See* Cisco Systems Inc., Cisco Visual Networking Index Complete Traffic Forecast (2017-2022) Q&A, https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/qa_c67-482177.html (last updated Nov. 26, 2018).

9 Cisco Systems Inc., Cisco Visual Networking Index: Forecast and Trends, 2017-2022, https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white-paper-c11-741490.pdf ("VNI White Paper").

countries.[10] Applied to the United States, the Forecast Highlights Tool contains important evidence the Commission should consider in this proceeding.

The VNI reflects that Wi-Fi is "the crucial link" to the Internet for numerous applications, and that the United States' reliance on Wi-Fi to carry enormous amounts of data will grow markedly over the coming years.[11] Wi-Fi carried 38% of total IP traffic in 2017, which will grow to 49% of total IP traffic in 2022.[12] Looking more narrowly at Internet traffic, the VNI shows that Wi-Fi will grow from 50.4% of total traffic in 2017 to 56.6% of traffic in 2022.[13] Those percentage increases are significant in isolation, but they represent staggering increases in the total data carried by Wi-Fi when taking into consideration that IP and Internet traffic will grow threefold in that time, with IP traffic in the United States growing from 468.2 exabytes in 2017 to 1.2 zettabytes (or roughly 1,200 exabytes) in 2022. Internet traffic in the United States will likewise grow from 337.2 exabytes in 2017 to 1.03 zettabytes (or roughly 1,030 exabytes) in 2022.[14] Thus, as Figure 1 below describes, in 2022 Wi-Fi will carry more than triple the amount of data than it did two years ago. That means that by 2022 Wi-Fi alone will carry more than all IP or Internet traffic in 2017 over any medium. Unless the Commission opens new frequencies for unlicensed operations now, rising demand will increasingly result in congestion and adversely impact the user experience.

---

[10] *See* Cisco Systems Inc., VNI Forecast Highlights Tool, https://www.cisco.com/c/m/en_us/solutions/service-provider/vni-forecast-highlights.html (last visited Feb. 11, 2019) ("VNI Highlights").

[11] NPRM ¶ 5.

[12] VNI Highlights.

[13] *Id.*

[14] *Id.* The VNI Forecast Highlights Tool reports Internet traffic at 28.1 exabytes per month in 2017, which is 337.2 exabytes for the full year, and projects the monthly figure to reach 85.8 exabytes by 2022, which is 1.03 zettabytes per year.

Figure 1: Total Data Carried by Wi-Fi in the United States

	2017	2022
IP Traffic	180 exabytes (*38% of 468.2 exabytes*)	588 exabytes (*49% of 1.2 zettabytes*)
Internet Traffic	170 exabytes (*50.4% of 337.2 exabytes*)	583 exabytes (*56.6% of 1.03 zettabytes*)

B. Use cases positioned for particularly high growth require significant additional unlicensed spectrum for low-power indoor operations.

Existing allocations for unlicensed spectrum simply cannot support the amount of data we expect in the near future. This creates a "pressing need for additional spectrum" for unlicensed operations like Wi-Fi, as both the Commission and Congress have recognized.[15] That need is particularly acute for many applications that will rely in large part on low-power indoor devices. The growth in demand for these devices makes Commission action to open the entire 6 GHz band to low-power indoor devices critical. Opening only two smaller sub-bands will not account for the bandwidth needs or channel sizes required to ensure support for consumer demand and U.S. leadership in emerging technologies. The VNI includes several specific examples.

Internet-Video-to-TV. Cisco projects that Internet-Video-to-TV traffic in the United States (for example, Netflix streaming through a Roku device, or a smart television connected directly to the Internet via Wi-Fi) will increase threefold between 2017 and 2022, and will remain approximately one half of fixed consumer Internet video traffic over that time.[16] Most of these streaming applications will rely on Wi-Fi to deliver content to a consumer's television, and will operate indoors, at power levels consistent with the NPRM's low-power indoor device class.

[15] NPRM ¶ 18; *see also* 47 U.S.C. § 1502(a)(2)(A).

[16] VNI Highlights.

As Ultra High Definition, 4K, and even 8K video quality standards and compatible televisions become commonplace, however, existing Wi-Fi spectrum resources will not be able to keep pace.[17] Connected 4K televisions will represent 76% of all flat-panel televisions in the United States by 2022, and will average data consumption of 49.6 gigabytes per month, up from 6.2 gigabytes in 2017.[18] The 802.11ax Wi-Fi standard promises more predictable performance for these kinds of applications,[19] but delivering on that promise requires additional spectrum resources.

Gaming. Cisco projects that gaming traffic in the United States will grow elevenfold from 2017 to 2022, reaching 7.2 exabytes per month (or 86.4 exabytes per year).[20] That data will account for 7% of total IP traffic in the United States. One reason for that growth is the shift from graphical processing on a gamer's computer or console toward cloud gaming, where "game graphics are produced on a remote server and transmitted over the network to the gamer."[21] Just as with Internet-Video-to-TV, next-generation consoles and other devices will rely heavily on Wi-Fi to deliver these massive amounts of data at very low latency, and will operate indoors and at power levels consistent with the Commission's low-power indoor device class. Without additional spectrum, these applications will suffer from poor quality or performance or create

---

17 *See* VNI White Paper at 8 (4K video streaming has a significant impact on data traffic "because the bit rate for 4K video at about 15 to 18 Mbps is more than double the HD video bit rate and nine times more than Standard-Definition (SD) video bit rate").

18 VNI Highlights.

19 *See*, *e.g.*, Cisco Systems Inc., *IEEE 802.11ax: The Sixth Generation of Wi-Fi* 1 (2018), https://www.cisco.com/c/dam/en/us/products/collateral/wireless/white-paper-c11-740788.pdf ("802.11ax White Paper").

20 VNI Highlights.

21 VNI White Paper at 28.

such a burden on available Wi-Fi resources that other Wi-Fi-dependent applications in consumers' homes will suffer.

Virtual Reality and Augmented Reality. Cisco projects that globally, virtual reality and augmented reality traffic will increase twelvefold from 2017 to 2022.[22] These applications have enormous potential for consumer and recreational use, specialized enterprise applications, and general business collaboration despite physical distance. Traffic growth will "ste[m] mainly from the download of large virtual reality content files and applications," but even more growth could come from "virtual reality streaming," which will require significant bandwidth to function properly.[23] Virtual and augmented reality technologies will operate mostly indoors, and at the low powers reflected in the NPRM's low-power indoor device class.

Indoor Smartphone Use. Smartphones accounted for 8% of IP traffic in the United States in 2017, and will account for 20% of IP traffic by 2022.[24] The VNI reveals that a key reason for smartphones' greater share of overall data traffic is "the growth of video viewing" on those devices.[25] A minority of increased smartphone traffic, from video viewing and other sources, will travel through outdoor channels, such as licensed mobile spectrum or outdoor Wi-Fi access points. But the majority will continue to travel via indoor access points—*e.g.*, smartphone use in the home or at the office.[26] Furthermore, indoor smartphone operations typically use power

---

22 *Id.* at 2.

23 *Id.* at 28.

24 VNI Highlights.

25 VNI White Paper at 7.

26 This is plainly, albeit indirectly, evident in the data reflected in the VNI Highlights for the United States. For example, the total demand for Consumer Internet Video will rise from 18.6 exabytes per month in 2017 to 57 exabytes per month in 2022, while usage for Consumer IP Video on Demand will rise from 9.8 to 14.7 exabytes per month over the same period. Adding these categories together, we see video demand of 28.4 exabytes per month

levels that are much lower than the Commission's low-power indoor device class. As with the applications discussed above, the performance of video streaming and other applications on smartphones depends significantly on increasing spectrum resources.

Internet of Things in the Home. Cisco projects that worldwide machine-to-machine connections, the traffic at the core of the Internet of Things, will more than double between 2017 to 2022, growing from 6.1 billion connections to 14.6 billion.[27] And "[c]onnected home applications" in particular, "such as home automation, home security and video surveillance, connected white goods, and tracking applications, will represent 48 percent, or nearly half, of the total M2M [machine-to-machine] connections by 2022."[28] Many of those home applications will communicate via Wi-Fi, and while bandwidth requirements will vary, 802.11ax Wi-Fi standards will support "dense IoT deployments" as needed.[29] The vast majority of these home IoT technologies will operate indoors, and at power levels consistent with the NPRM's low-power indoor device class.

---

in 2017 rising to 71.7 exabytes per month in 2022. We can then compare that total demand to how the various access platforms are growing: (1) fixed/wired networks will grow from 23.1 exabytes per month to 47.1 exabytes per month; (2) fixed/Wi-Fi will grow from 14.7 to 49.7 exabytes per month; and (3) mobile traffic (*e.g.*, traffic on licensed spectrum) will grow from 1.2 to 5.7 exabytes per month. Two things are clear: First, mobile data traffic is a fraction of total video demand, and while subscribers will increasingly watch video on smartphones and other mobile devices, this access platform is too capacity constrained to explain the very large growth in the video consumption categories. Second, users will continue primarily to watch video on Fixed/Wi-Fi or Fixed/Wired networks, which are overwhelmingly indoors and projected to remain so.

[27] VNI White Paper at 11.

[28] *Id.*

[29] *Id.* at 21.

III. THE FULL 6 GHZ BAND IS NEEDED TO EFFECTIVELY SUPPORT LOW-POWER INDOOR OPERATIONS.

The 6 GHz band is an ideal location to provide the unlicensed spectrum resources needed to support the rapid-growth technologies the VNI identifies. Restricting low-power indoor operations only to the U-NII-6 and U-NII-8 sub-bands, however, would be at best a half-measure, increasing the cost of next-generation Wi-Fi devices, delaying their development and production, and slowing downstream speeds for consumers. The Commission should instead permit low-power indoor operations in all 6 GHz sub-bands.

A. The 6 GHz band is an ideal location for additional unlicensed spectrum supporting low-power indoor operations compared to higher frequencies.

The 6 GHz band is an ideal location to address the nation's unlicensed spectrum challenge for several reasons. First, the 6 GHz band is proximate to the successful 5 GHz bands, with their highly developed equipment ecosystem. Building additional unlicensed capacity near the 5 GHz bands will facilitate the rapid and efficient introduction of the next generation of Wi-Fi technologies, leading to higher-capacity capabilities in *both* the 5 GHz bands and the 6 GHz band.

This is because chipset manufacturers can produce integrated chipsets that support either or both bands,[30] and equipment makers will in turn be able to produce access points and devices that are 5 GHz and 6 GHz-compatible more quickly and in a more cost-efficient manner. By contrast, were the Commission to look to another frequency range to expand unlicensed spectrum, the transition would be far more cumbersome and inefficient. Cisco anticipates that consumer-ready devices to support 6 GHz Wi-Fi should be available as soon as a year within the Commission's issuance of final rules because of these engineering efficiencies.

---

[30] *See*, *e.g.*, Comments of Broadcom Ltd., GN Docket No. 17-183, at 9 (filed Oct. 2, 2017).

The proximity to 5 GHz also will create networking efficiencies once the Commission makes 6 GHz spectrum available for unlicensed technologies. Because the propagation characteristics of 6 GHz and 5 GHz spectrum are similar, access points and devices equipped to use both will be able to guide traffic to the clearest available frequencies across a larger number of channels, creating network effects that increase the value of the combined bands above that of either band in isolation. Particularly in dense operating environments, traffic can be managed efficiently with these additional channels, sharing the load across channels least likely to have congestion. 6 GHz spectrum could therefore be the optimal location for the expected traffic and density growth for low-power indoor devices identified in the VNI.

These efficiencies would be lost, however, if the Commission turned to other frequencies for unlicensed growth, such as millimeter wave spectrum. While these bands will open opportunities for future unlicensed technologies, chipmakers and manufacturers could not meet current and expected demand using these frequencies. The propagation characteristics of this band are far different from those in today's core unlicensed bands. Millimeter wave devices have far inferior propagation compared with mid-band devices—for example, they cannot penetrate walls—and would be inappropriate for most widespread unlicensed technologies, better supporting point-to-point service. These inefficiencies would extend to client devices, as well: Power-limited devices (*i.e.*, those that depend on battery power, such as a smartphone, tablet, or laptop) realize significantly greater energy losses operating at (for example) 60 GHz than at 6 GHz.

B. The full 6 GHz band is needed to deliver on the promises of next-generation Wi-Fi and meet near-term traffic demands, especially for low-power indoor devices.

The Commission's overall approach in the NPRM is forward-thinking and will greatly advance innovation and economic growth. But the NPRM's proposal to limit low-power indoor

operations only to the U-NII-6 and U-NII-8 bands would cripple this key product segment. First, limiting low-power indoor devices to a minority of the band would allow only *one* new 160-megahertz-wide channel for low-power indoor use (in the U-NII-8 band). One new channel will not meet expected demand even for today's devices, much less prepare the country for the growth the VNI sees over the next five years. Second, blocking U-NII-5 and U-NII-7 for the most popular devices and applications would severely reduce incentives for manufacturers to design access points and client devices. Third, this limitation would greatly lengthen the time it would take for consumers and businesses to access the band because of the longer time it will take for the development of AFCs and AFC-controlled standard-power devices.

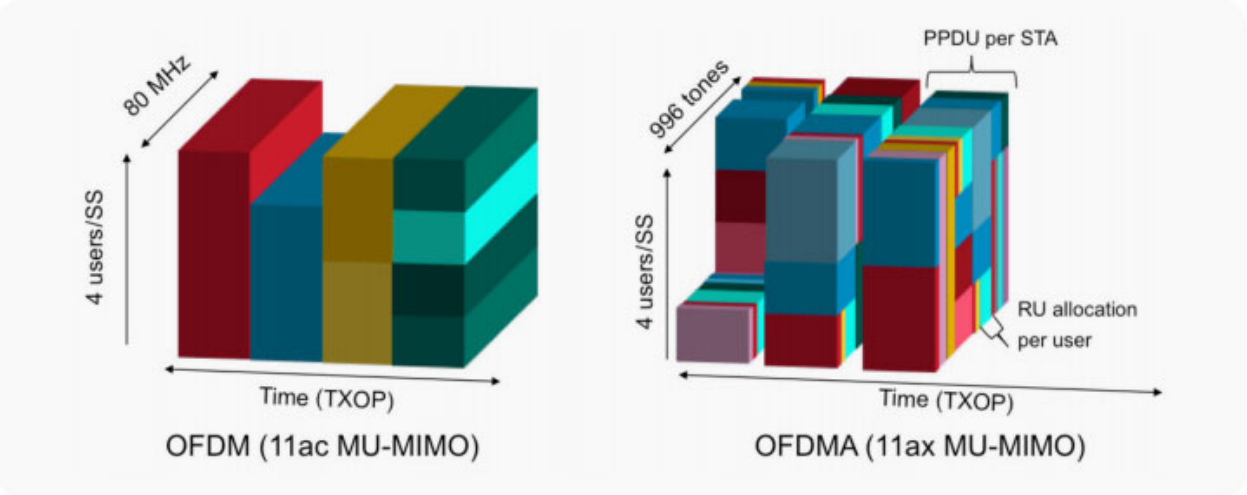
By contrast, permitting low-power indoor operation throughout the 6 GHz band could allow up to *seven* potential 160-megahertz-wide channels. The Wi-Fi industry already is delivering the technology to take advantage of 160-megahertz channels in 802.11ac products, but the 5 GHz bands cannot support these wide-channel operations. Once the Commission opens the 6 GHz band, populating the new 160-MHz channels with low-power indoor devices will be rapid. These wide channels will make an enormous difference achieving the new Wi-Fi 6 standard's full potential to support U.S. consumers and businesses.

160-megahertz channels can carry more information in less time than can narrower channels, as channel bandwidth is a strong determinant of wireless speed.[31] But under the 802.11ax standard, these wider channels will also offer increased throughput while occupying the channel for less time than under current standards. That is because 802.11ax will also implement Orthogonal Frequency-Division Multiple Access ("OFDMA"), a channel-access

[31] *See*, *e.g.*, 802.11ax White Paper at 5.

mechanism that divides channel sub-carriers among numerous users in a way that 802.11ac and other standards could not.[32] Whereas the 802.11ac standard accommodates multiple users by dedicating the full channel to each user for a unit of time, 802.11ax will break the channel down into subcarriers that can be allocated to users more efficiently depending on their throughput needs.

Figure 2: 802.11ac Multiplexing Versus 802.11ax Multiplexing[33]



Thus, a 160-megahertz channel will be able to produce the link margins necessary to, for example, stream video programming on a 4K television, while using spectrum resources more efficiently and using far less energy.

That efficiency is important for a number of real-world scenarios. For example, in dense urban environments where multiple, unrelated access points may all be broadcasting in close proximity, the overall noise level can remain lower and more distinct uses can coexist without signal degradation. In addition, shorter transmission times save power by allowing the device to sleep more. That is very important for managing client-device battery life—smartphones and

---

[32] *E.g.*, *id.* at 6.

[33] *Id.*

tablets, for example, must be able to take advantage of next-generation Wi-Fi without requiring frequent recharging.

Facilitating more 160-megahertz channels in the 6 GHz band will help maximize the potential of these technological advances. Simply put, more wide channels mean more throughput potential, whether in office buildings, apartments, or single-family homes. In managed environments—*e.g.*, in enterprise deployments—the larger footprint of available spectrum would also allow for network designs that maintain maximum frequency separation between channels in use on physically adjacent access points. That frequency separation can work hand-in-hand with the advanced 802.11ax standard to allow the most efficient use of every channel while requiring minimal resources to manage competing traffic. Likewise, in mesh deployments, having multiple available 160-megahertz channels allows for efficient backhaul to keep the network functioning smoothly. All those benefits would be largely lost, however, under the current proposal to limit low-power indoor spectrum to the single 160-megahertz channel available under the NPRM's proposal.

IV. CONCLUSION.

Cisco congratulates the Commission on continuing its long tradition of leading the world in spectrum policy. The overall approach of the NPRM will produce important benefits for consumers, support economic growth, and advance innovation. The Commission has correctly identified the 6 GHz band as critical to addressing the nation's need for additional unlicensed spectrum resources. But the viability of that spectrum to support the high-traffic, fast-growing uses of unlicensed spectrum identified by the VNI—higher-quality streaming television, gaming, virtual and augmented reality, indoor smartphone use, and home IoT—would be threatened if the Commission were to limit low-power operations to less than half of the new spectrum in the 6 GHz band. In order for users, both enterprise customers and residential consumers alike, to

realize the benefits of next-generation Wi-Fi for the most popular devices and applications, the Commission should permit the low-power indoor device class to operate throughout the 6 GHz band.

Respectfully submitted,

CISCO SYSTEMS, INC.

By: Mary L. Brown
Senior Director
Technology and Spectrum Policy
Government Affairs
601 Pennsylvania Ave., NW
9th Floor North
Washington, DC 20004
(202) 354-2923

February 15, 2019